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Final Report for NASA PO S-97229-E (CSC Task #5797), Voyager GO Program

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This contract pertained to the investigation of the time variability of the ultraviolet continuum flux of three stars, lambda Eri, 53 Persei, and gamma Cas. The observations were conducted in 1991 and were provided to the Principal Investigator in December of 1992. The investigator traveled to Tucson, Arizona to reduce the data in February of 1993 and analyzed the data during the spring and summer of 1993.

The Voyager observations of 53 Persei were conducted simultaneously with a global ground-based campaign of visual-wavelength photometry. The optical campaign established beyond doubt the existence of two nonradial pulsation modes with periods near two days. Using the ephemeris from the ground-based campaign we were able to predict the time variability for the optical results with one unknown parameter. The Voyager results showed the variability with the predicted period and phase, permitting us to determine the amplitude in the ultraviolet. Combining the visual and ultraviolet amplitudes, we were able to compare their ratio with that predicted for nonradial pulsation modes from theory. Our results show that the pulsation modes of this star can be described by a spherical harmonic index, l , of 2 or 1 (less probable). A scientific paper summarizing these results was published in the Proceedings of the IAU Colloq. 162 in 1994.

The second part of the program concerned the ultraviolet continuum modulations of the B2e star lambda Eri. These observations were conducted in November, 1990. The data were combined with IUE and optical data and published in a paper cited below as Smith and Polidan 1993 and Smith 1994b.

Voyager observations of lambda Eri showed that the ultraviolet light curve of lambda Eri shows no variations over a timescale of a day, but may show excursions on the order of an hour. There was little actual overlap between the Voyager and IUE datasets in time so we could not determine whether the short-term variations from Voyager are instrumental or from the star. However, the absence of variations at times coinciding with the formation of spectral transients called "dimples" in the optical lines of this star puts important upper limits on the masses of the plasma structures responsible for the dimples.

The third and final part of the program concerned the ultraviolet continuum variations of the B0.53 star gamma Cas. These data were obtained in 1990 and 1991. The results were submitted to the Astrophysical Journal and are scheduled to be published in their April 1, 1995 issue (see below).

The Voyager observations of gamma Cas show that 10-20% variations occur on a timescale of 1-2 hrs. and are commonplace. A difference spectrum formed from high and low flux states shows a spectrum indistinguishable from the low-state (photospheric) spectrum. Moreover, a histogram formed from the differences of flux from adjacent observations is very similar to histograms formed from light curves from two x-ray satellites, suggesting that the ultraviolet and x-ray continuum variations have the same origin. If correct, this association casts doubt on the popular view that the x-ray emission from this star arises from a wind-fed accretion disk around a degenerate companion to this star. Rather, we suggest that the x-ray emission arises from localities near the surface of the Be star itself.

Publications from Contract:

- Smith, M. A., and Polidan, R. S. 1993, "Dynamic Processes Be Star Atmospheres II. "Dimple Formation in the HeI 6678A Line of lambda Eri," ApJ, 408, 323.
- Smith, M. A., and Huang, L. 1994a, "NRP Mode Typing for 53 Persei: Results from Voyager Photometry," Rotation, Pulsation, and Mass Loss, ed. L. Balona and H. Henrichs, (Dordrecht: Kluwer), p. 37.
- Smith, M. A. 1994b, "Photospheric Activity in Selected Be Stars," Rotation, Pulsation, and Mass Loss, op. cit., p. 241.
- Smith, M. A., 1995, "Dynamic Processes Be Star Atmospheres III. Rapid Multi-Wavelength Variability in Gamma Cas," ApJ, 492, --- (4/1/95).